Final Project Report

Small and Medium Mammal Species Inventory within Biscayne National Park, Florida

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Purpose

The goal of this study was to inventory the small- and medium-sized mammal species at four mainland locations and seven Keys within the Biscayne National Park, Florida to provide baseline data for future management strategies.

Methods

1. Trapping locations and dominating plant communities

Overall, we live-trapped and visual surveyed small- and medium-sized mammal species on four mainland locations and on seven Keys within the boundary of Key Biscayne National Park. Each trapping site was selected to correspond to the GIS locations (UTM units) of the previously carried out vascular plant inventories. We used the vegetation cover database (provided by Mr. M. Paterson South Florida/Caribbean Network Coordinator) to specify the plant community at each trapping grid.

On the mainland we selected two trapping grids north and two south of Black point. The two northern grids were classified as B10 (567746 to 2824755) and B8 (567419 to 2824432). The two southern locations were classified as TUR27 (566006 to 2816701) and TUR29 (565953 to 2816900). We trapped the northern grids B10 and B8 from June 25 – 30, 2002. The plant community at B10 was dominated by red mangrove

(*Rhizophora mangle*), while at B8 a "mixed mangrove" community was dominant. We trapped on the southern grids TUR27 and TUR29 from July 15 – 19, 2002. The plant community at both TUR27 and TUR29 was dominated by red mangrove (*Rhizophora mangle*), mixed shrub, and buttonwood (*Conocarpus erectus*).

On Elliot Key, we trapped at four different locations E17 (580964 to 2815030), E19 (580965 to 2815532), and E18 south and E18 north (both along 581181 to 8815755) from September 5 – 9, 2002. E17 and E19 were trapped from October 31 until November 4, 2002. At both locations mid-successional hardwood hammock forest was the dominant vegetation. At E18 north and E18 south an older successional hardwood hammock was the main plant community.

We trapped at three different locations on Boca Chita Key, BC1 (582986 to 2823363), BC2 (582749 to 2823117) and BC4 (582927 to 2822995). BC1 and BC2 were trapped from December 13 – 16, 2002. BC4 was trapped for only two days from December 17 –18, 2002. The plant community at BC1 and BC2 was dominated by graminoid prairie, slash pine and hardwood plant. BC4 was dominated by a subtropical hardwood forest.

On Sands Key, we trapped at two different locations. Because we did not have any location points from previous vegetation censuses, we determined the location of both trapping grids. We attempted to cover different vegetation types found on that Key. The first trapping grid was located (N 2550351 to W 08017950) going for 100 meter eastward. Here the vegetation was dominated by Red (*Rhizophora mangle*) and Black Mangroves (*Avicennia germinans*and) and a mixed hardwood forest with dense ground cover. The second trapping grid was located (N 25050454 to W 08018064) extending 100 meter northward. The vegetation was savanna like, and consisted of a low density of small trees on exposed gravel ground.

On Adams Key, we trapped at two different locations (N 2537910 to S 08018044) and (N 2539771 to S 08023361). Both grids were trapped from February 9 – 13, 2003. The dominating plant community was a mid-successional hardwood hammock forest.

We trapped at two different locations on Old Rhodes Key (N 2535670 to S 08022760) and (N 535676 to S 08022704). We trapped both grids from April 16 – 20,

2003. A mid-successional hardwood hammock forest dominated the plant community at both locations.

On Totten Key, we trapped at two different locations (N 2538748 to S 08024672) and (N 3538726 to S 08024694). Both grids trapped from June 4 – 7, 2003. The plant community was dominated by Red (*Rhizophora mangle*) and Black Mangroves (*Avicennia germinans*and), and a mixed hardwood forest with spars ground cover and bare rocky terrain.

Because of difficulties finding enough dry ground where we could established a trapping grid (without endangering trapped animals), we could only trap on one location along the periphery of the Long Arsenicker Key (N 2537663 to W 08029586) and (N 253767 to W 08029681). We established the single 100 meter trap line, which consisted of 10 Sherman and 10 Tomahawk traps from October 20 – 23, 2003. The plant community was dominated by thick Red (*Rhizophora mangle*) and Black Mangroves (*Avicennia germinans*and). Along the edge of the island the sandy ground was partially flooded while in the interior of the island numerous ground depressions were permanently filled with salt water.

We attempted to establish trapping grids on the remaining Arsenicker Keys, including West Arsenicker, Arsenicker Key and Eastern Arsenicker Key. However, the shallow water level and/or the dense vegetation prevented us from reaching the Keys. Future trapping effort would require a different boat and a Park permit to cut trails on these Keys.

2. General trapping design and data collection

Each trapping station and trap line was spaced 10 meters apart. Each trap line consisted of 10 Sherman traps (4 x 4 x 12 inches). At every second station we additionally had a medium sized Havahart live trap (8 x 8 x 21 inches). Starting at the second trapping session on Elliot Key, we replaced the Havahart traps with larger Tomahawk live traps (10 x 11 x 28 inches). Each trapping grid consisted of 20 Sherman and 10 Havahart or Tomahawk traps and covered an area of 1000 square meters. For five consecutive days we baited the Sherman traps with a mixture of peanut butter, vanilla extract, and rolled oats, while we used caned sardines for the Tomahawk traps.

We recorded the following data from captured animals: species, gender, and trap location. All small mammal species will be marked with unique numbered ear tags. However, because raccoons are potential carrier of rabbis and are difficult to handle without sedation, we will not ear tag individual animals. In addition, we recorded sexual reproductive conditions; for males: either descended testes into scrotum (adult) or still abdominal (juvenile and subadult), for females: vagina open or closed, pubic symphysis open/closed, nipples size, small, swollen or lactating (Kunz et al. 1996.).

In addition to our trapping methodology, we attempted to identify any sign of mammal species including footprints, fecal pellets, bone remains etc. whenever we encountered them.

Results

1. Mammals species on the Mainland Sites

On the mainland north of Black point at B10 we trapped two adult male black rats (*Rattus rattus,* Figure 1) and one adult female Virginia opossum (*Didelphis virginiana*). In addition, we visually encountered four common raccoons (*Procyon lotor,* Figure 2) at one single occasion being fed by fishermen. At a later occasion we encountered one raccoon and one rabbit (probably a marsh rabbit, *Sylvilagus palustris*). We did not encounter other mammals or signs (i.e. droppings, foot prints etc). On B8 we trapped only one adult male black rat (*Rattus rattus*). We did not encounter other mammals or mammal signs. However, we encountered on three consecutively days an approximately 5 feet long American Crocodile (*Crocodylus acutus*). On the TUR27 we did not trap any mammals. However, on TUR29 we trapped two juvenile male black rats (*Rattus rattus*). One adult black rat escaped while handling, therefore, we have no data on gender and sexual reproductive status.

2. Mammals species on the Keys

Elliot Key - Both E17 and E19 locations we neither trapped nor visually encounter mammals or any signs. After that trapping period we replaced the Havahart traps with larger Tomahawk live traps. On the northern E18 trapping grids we obtained two adult females (one lactating) and one juvenile male raccoon (*Procyon lotor*). On the

southern grid E18 we trapped eight males (six adults, and two juveniles) and two female raccoons (one lactating). One juvenile was sick and had severely limited mobility. It was beyond the scope of this study to determine the cause of this condition.

Boca Chita Key - At all three locations we neither trapped nor visually encountered any signs of small or medium sized mammal species.

Sands Key - From 20 to 23 of January 2003 we trapped on Sands Key. Because of a storm warning with 15-20 knots we had to discontinue the trapping one day earlier. On the first location we trapped one adult male and four adult female black rats (*Rattus rattus*). In addition, we trapped six females (fife adults and one juvenile) and two adult raccoons (*Procyon lotor*). On the second savanna like location we trapped only one adult female black rat (*Rattus rattus*). Additionally, we trapped four females (one juvenile and three adults) and two male (one juvenile and one adult) raccoon (*Procyon lotor*). Because we did not individually mark raccoons, we could not distinct among new individuals and recaptures. However, on the second trapping day we captured a total of nine raccoons in both trapping grid, (five in the first and four in the second grid). This suggested an unusual high population density of raccoons. Interesting is also that on Boca Chita Key, which is just north of Sands Key and only separated by the Lewis Cut, we did not encounter any mammal species. Sparse vegetation on Boca Chita might not provide sufficient food, shelter, cover and water resources for mammals. However, other factors such as proportionally higher hurricane disturbance on Boca Chita might also account for the lack of mammals.

Adams Key - On the N-grid we trapped one adult male black rat (*Rattus rattus*) in sexual reproductive condition. In addition, we trapped five females (one juvenile under 1kg, and four subadults) and one male juvenile raccoon (*Procyon lotor*). On the S-grid we trapped three juvenile male black rats (*Rattus rattus*). Also, we trapped three females (one juvenile under 1kg, and four subadults) and one juvenile male raccoon (*Procyon lotor*). Interestingly, we did not trap any adult raccoon. However, sexual reproductive adults must be resident on the island, otherwise we would not have obtained juvenile/subadult individuals. One reason for the high number of young animals might be that the resident rangers frequently “relocates” individuals therefore the population might be below its carrying capacity and reproduction could be higher compared to other Keys.

More black rats were found on the S-grid, which is close to the port and the beach area. The vegetation on S-grid is not as dense as on the N-grid, furthermore and remains from demolished buildings, and abundant trash might provide microhabitats such as cover, shelter and collect fresh water (i.e., rain) for animals.

Old Rhodes Key - On the N-grid we trapped one juvenile male black rat (*Rattus rattus*). Furthermore, we trapped two female (one juveniles, and one subadult), and three males (one juvenile and two adult) raccoons (*Procyon lotor*). On the S-grid we trapped only two female and two juvenile raccoons (*Procyon lotor*), as well as two adults males raccoons.

Totten Key - At the first trapping grid we trapped two adult male and one female black rats (*Rattus rattus*). Also, we trapped two adult male raccoons (*Procyon lotor*). On the second trapping grid we trapped one adult male and two (one juvenile one adult) female black rats (*Rattus rattus*). In addition, we obtained two subadult males and subadult female raccoons (*Procyon lotor*).

Long Arsenicker Key – Because of the inaccessibility and standing water we were only able to establish one 100 meter long trap line. Here we obtained one juvenile male black rat (*Rattus rattus*) and two males (one subadult and one adult) raccoons (*Procyon lotor*).

During our boat trips from and to the Keys we observed on numerous occasions marine mammals including West Indian manatees (*Trichechus manatus*) and bottle-nose dolphins (*Tursiops truncates*) and one dead sea turtle which was tangled in a fishing net.

Discussion and management recommendations

Key Biscayne National Park consists of over 42 Keys of various sizes, which vary in distances from the mainland, hurricane disturbance and plant communities. Only a few Keys provide public docking facilities, trails, picnic areas and campgrounds for recreational purposes. Therefore, human disturbance should be minimal on most of the Keys. Thus the Park could be a crucial offshore refuge for numerous animal species including local and seasonal migratory bird species as well as providing nest sites for five endangered sea turtle species within South Florida.

In this study, we quantified the small- and medium-sized mammal species in four mainland locations and on seven Keys. To our knowledge this was the first comprehensive study of the mammal communities within Key Biscayne National Park. Therefore, our results provide baseline data on the distribution of species, which is crucial for future management strategies. Overall our findings indicate a very poor species richness of mammals within Key Biscayne National Park. At all trapping locations we encountered only exotic black rats (*Rattus rattus*) and native raccoons (*Procyon lotor*). The mainland was the only location where we additionally obtained the native Virginia opossum (*Didelphis virginiana*). Both, raccoons and back rats are extreme habitat generalist (e.g., Ewer 1971, Nowak 1991). This was also supported by our observations in the park. After releasing trapped individuals we observed on numerous occasions raccoons and black rats climbing up trees. Also, we observed raccoons escaping after being released by swimming. Both species are omnivore and consume fruits, seeds, arthropods, turtle and lizard eggs as well as their hatchlings and adults (Wace 1986, Nowak 1991, Renfrew and Ribic 2002) On most Keys, the relative density of both species was unusual high, and individuals appeared well fed. It should be noted that we trapped a large number of juvenile/subadult raccoons on Adams Key. This was probably a result of repeated removal of adults prior to our survey. We did not encounter any mammals on the small Boca Chita Key. This is surprising considering the high density of raccoons on nearby Sands Key. Sparse vegetation might not provide sufficient food or cover for mammals.

Because there are no previous studies, which quantified the mammal species on the Keys, it is unclear if the mammal communities have changed over time. Native small/medium mammals such as the deer mouse (*Peromyscus gossypinus*), cotton rat (*Sigmodon hispidus*), rice rat (*Oryzomys palustris*), marsh rabbit (*Sylvilagus palustris*), round-tailed muskrat (*Neofiber alleni*) and Virginia opossum (*Didelphis virginiana*) occur in a variety of habitats within in the Everglades (Gaines et al. 2002), as well as along the beaches in Cape Canaveral Seashore (Gaines et al. unpubl. data). The home page of the Key Biscayne National Park (http://www.nps.gov/bisc/pphtml/facts.html) lists additional small- and medium sized mammal species including the engendered Key Largo Woodrat (*Neotoma floridana smalli*) and the bobcat (*Lynx rufus*). It remains

uncertain if black rats and raccoons out-competed native mammal species, and preventing them from reestablishment.

What factors may account for the high number of black rat and raccoon populations within the Park?

1 Food resources:

Both black rats and raccoons are omnivorous and consume a vide variety of food including fruits, arthropods, turtles, as well as their eggs and hatchlings (e.g., Wace 1986, Nowak 1991). This predation pressure may result in lower survival, recruitment, density and potentially local extinction of prey species (e.g., Wace 1986). Therefore, we would expect an equilibrium between pray and predator density. However, additional food resources such as dead fish or litter may allow and sustain higher densities.

2. Fresh water supply:

Fresh water is a major limiting factor for most animal species inhabiting islands surrounded by brackish or saltwater. None of the Keys has a natural fresh water supply. Therefore, non-flying animal species depend on dew or rainwater. Natural formed water reservoirs may provide water over an extensive time period. Certain food resources such as fruits may provide water during the fruiting season.

We hypothesize, however, that human activities increase fresh water supply. According to the ranger on Adams Key, raccoons utilize the condense water generated by the air conditioner. Although we did not do a systematic survey we noticed large accumulations of washed up garbage along the shorelines of the mainland and along all Keys, which may provide additional fresh water reservoirs. The trash includes boat lines, nets, bottles, cans, refrigerators, coolers, etc. Trash such as boat, fishing lines and nets may tangle and kill wildlife such as birds and endangered sea turtles. Some Keys have trash accumulated up to 25 meters into the interior. In addition, on Adams Key large demolition refuse from buildings were found. Most Keys are long and not wide, resulting in a large circumference to area ratio. Thus, most small and medium sized mammals could include some shoreline with a fresh water supply within their home range.

What are potentially ecological consequences of the high black rat and raccoon populations within the Park?

Overpopulation of the native raccoons and exotic black rats may not only out-compete native small mammals but also affect other animal taxa. Historically, seven of the 42 Keys had sandy beaches, which provided nesting grounds for endangered sea turtles. However, recently the survival rates of turtles on these beaches have been less than 10% (Patterson pers. com). The high morality rates of turtle has been linked to raccoon predation. One management strategy is raccoon exclosures around turtle nests, which improves survival of turtle eggs. In addition, numerous studies, including on oceanic islands, demonstrated that both raccoons and black rats can drive animal pray species into extinctions. (e.g. Novak 1991 and citations therein).

Considering our findings we make the following recommendation for the mainland and targeted Keys located within Biscayne National Park:

1. Frequent removal of all washed up trash from the shorelines and Key interior.
2. Inventory and removal of the all demolished building refuses, particular from Adams Key.
3. Preventing mammals from gaining access to the air condition generated condense water on Adams Key.
4. "Complete" extirpation of black rats and reduction of raccoon density.
5. Monitoring of raccoons for infectious disease such as rabies, which could spread to other species and thereby negatively effecting re-colonization success.
6. Educational and outreach programs to inform the general public about the existing problems and solutions.
7. Strengthening law enforcement particularly littering and feeding animals.

Future research opportunities

1. Quantifying nest predation

Investigating the effects of raccoons and black rats on turtle and bird egg predation could be experimentally tested by putting commercially acquired bird eggs (e.g., quail eggs) at random locations in several Keys and following their fate through time. In addition, if raccoons and black rats were removed from several Keys then we would predict that egg predation would be lower on these Keys when compared to control Keys where raccoons and black rats are still present.

2. Fresh water access

Comparing the population density, survival and reproductive success of raccoons and black rats on Keys with and without trash removal would provide insights into the role of fresh water availability on the population dynamics of these mammals.

3. Density and species diversity

Comparing the densities and species diversities of small mammal, bird and reptile species on Keys with and without raccoons and black rats would provide insights into the impact of these omnivorous predators on species diversity and densities.

Some of the Keys (particulary Keys near the mainland or large in area) could have historically functioned as *a source habitat* by permitting surplus recruits of a given species to immigrate onto Keys where this species experiences a higher mortality than recruitment *a sink habitat* (Pulliam 1988). Thereby, the source population could maintain a sink population via dispersal (e.g., Beck et al. 2004). Alternatively, a locally extinct population could re-colonize a given Key if metapopulation dynamics would occur. Both, source-sink and metapopulation dynamics are fundamental ecological mechanisms, which can explain the spatio-temporal distribution of populations and increased species diversity. Hence, these mechanisms deserve special attention in any conservation effort, and particular in the spatial settings of the Keys within the Key Biscayne National Park.

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Table 1. Summary of the trapping locations, their most dominant plant community and the total number of black rats (*Rattus rattus*) and raccoons (*Procyon lotor*) trapped on four mainland (Black Points and Turkey Point) locations and on seven Keys (islands) within Key Biscayne National Park, Florida.

Trapping Locations	Dominating Plant Community	# of Black rats	# of Raccoons
Black Point 1	Red mangroves	2	4
Black Point 2	Mixed mangroves	1	0
Turkey Point 1	Red mangroves	0	0
Turkey Point 2	Mixed mangroves	3	0
Elliot Key 1	Young hardwood hammock	0	0
Elliot Key 2	Young hardwood hammock	0	0
Elliot Key 3	Old hardwood hammock	10	0
Elliot Key 4	Old hardwood hammock	0	3
Boca Chita Key 1	Prairie and Pine forest	0	0
Boca Chita Key 2	Prairie and Pine forest	0	0
Boca Chita Key 3	Hardwood hammock	0	0
Sands Key 1	Mixed mangroves	5	8
Sands Key 2	Savanna and bare ground	1	6
Adams Key 1	Young hardwood hammock	1	6
Adams Key 2	Young hardwood hammock	3	4
Old Rhodes Key 1	Young hardwood hammock	1	5
Old Rhodes Key 2	Young hardwood hammock	0	4
Totten Key 1	Mixed mangroves	3	2
Totten Key 2	Mixed mangroves	3	4
Long Arsenicker Key 1	Red mangroves	1	2

Figure 1. Adult black rat (*Rattus rattus*) trapped on the mainland within the boundary of Key Biscayne National Park, Florida.

Figure 2. Adult raccoon (*Procyon lotor*) trapped on Elliot Key in Key Biscayne National Park, Florida.